





Fermilab Core Capabilities

Joe Lykken FY2016 Core Capability Review February 1, 2016

Introduction

Fermilab has four core capabilities that define the scope of the lab's strategic plan. The core capabilities are:

- Accelerator Science and Technology
- Advanced Computer Science, Visualization, and Data
- Large-Scale User Facilities / Advanced Instrumentation
- Particle Physics

Each core capability is defined in terms of:

- Relevance to DOE/DHS missions and national needs
- Unique and/or world-leading aspects
- Combination of facilities, equipment, teams of people
- Primary sponsors



Strategy Map with Core Capabilities

DOE Office of Science Mission

Accelerator Science and Technology Advanced
Computer Science,
Visualization, and
Data

Large-Scale User
Facilities /
Advanced
Instrumentation

Particle Physics

Goal: Maintain and enhance a diverse science program.

Major Initiatives:

- LCLS-II
- PIP-II
- HL-LHC

Major Initiatives:

- HEP Cloud
- Active Archival Facility
- art scientific workflow system

Major Initiatives:

- LBNF/DUNE
- CMS Upgrades

Major Initiatives:

- Neutrino Science
- CMS Science
- Muon Science
- Cosmic Science

People and Infrastructure

Major Initiatives: Diversity and Inclusion, Integrated Engineering Research Center



DOE Office of Science Mission

ASCR

- Mathematical models, methods, algorithms
- Computational science

BES, NP

 Develop new accelerator technologies to advance forefront user facilities

HEP

- Elementary particles
- Fundamental forces
- Forefront user facilities
- Steward accelerator science

WDTS

- Increase research talent
- Unique opportunities to mentor students & faculty
- Expand under-represented students & faculty in STEM
- High-gradient and high-quality-factor SRF cavities: World-renowned core competency in fabricating and testing superconducting radio-frequency (SRF) cavities and cryomodules and associated cryogenic systems.
- High-field superconducting magnets: Core competency in developing and delivering advanced superconducting magnets and associated cryogenic systems.
- **High-intensity beams**: The most powerful high-energy particle beam for neutrino experiments.
- SRF R&D, design, fabrication, and test facilities: Facilities for SRF cavities and cryomodules.
- Magnet test facilities: Test facilities for superconducting magnets and conventional magnets.
- Accelerator test facilities: Fermilab Accelerator Science and Technology (FAST) facility, High Brightness Electron Source Laboratory (HBESL), and PIP-II Injector Experiment (PXIE) test facility.
- U.S. Particle Accelerator School: National program providing graduate-level training and workforce development to scientists and engineers in the science of particle beams and accelerator technologies.

High Energy Physics (HEP)



Basic Energy Sciences (BES)

Advanced Computer Science, Visualization, and Data

DOE Office of Science Mission

JOE/DHS Missions

Unique and/or World -Leading Capabilities

and People **Facilities**

Primary

ASCR

- Models, methods, algorithms
- Computational science
- Computing and networking
- Networking & collaboration tools and facilities

HEP

- Elementary particles
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NP

- · Search for undiscovered forms of nuclear matter
- Use neutrinos to study matter-antimatter asymmetry and BSM

WDTS

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- CMS Tier-1 Center: One of seven Tier-1 grid computing centers and the most powerful worldwide for the CMS experiment. Second largest computing facility (after CERN) for LHC Computing.
- **FermiGrid**: The primary facility for non-LHC computing in HEP ("Tier 0" for Neutrino and Muon Science).
- Lattice QCD Computing: Largest of the three U.S. Lattice QCD computing centers (BNL, FNAL and TJNAF).
- High-performance computing algorithms, simulations, and scientific workflow systems.
- **Fermilab computing facility** consists of 80,000 CPU cores and 30 petabytes of cache.
- Active Archival Facility consists of robotic tape storage w/ exabyte capacity for broad scientific community.
- Scientific Computing Division includes core competencies in R&D and computing architectures, facilities, science workflows and operations. The Division includes developers of high-performance computing algorithms, science analysis frameworks, workflows, sophisticated simulations, and data analytics toolkits.

Advanced Scientific

High Energy Physics (HEP)



Computing Research (ASCR)

DOE Office of Science Mission

Missions

Unique and/or World -Leading Capabilities

and People **Facilities**

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- The nation's largest accelerator complex (second largest in the world).
- The world's only laboratory providing low- and high-energy neutrino beams simultaneously.
- Unique capability in large-scale cosmic-detector and particle-detector integration and testing.
- Key partner in R&D for X-ray detectors as well as cosmic- and particle-detector technologies.
- Fermilab Accelerator Complex consists of seven particle accelerators and operations staff to provide particle-beam capabilities found nowhere else in the world.
- CMS Center consists of LHC Physics Center (LPC), Remote Operations Center (ROC), and U.S. CMS Computing Facility and operations staff.
- **Test Beam Facility** provides high-energy hadron beams for detector R&D.

High Energy Physics (HEP)



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- World's only facility that operates short- and long-baseline neutrino oscillation programs.
- Leading U.S. center and second largest world center (after CERN) for energy-frontier science.
- World-leading survey for dark energy and cosmic neutrinos.
- Unique capabilities in the search for low-mass dark matter.
- Neutrino science: MicroBooNE, MINERvA, MINOS+, and NOvA scientists and operations staff.
- CMS Science: Compact Muon Solenoid (CMS) experiment and scientists and operations staff.
- Cosmic Science: Dark Energy Survey (DES) and Dark Matter program including scientists and operations staff.
- Education Office & Lederman Science Center support STEM education and science literacy.
- Theory Group and Theoretical Astrophysics Group

High Energy Physics (HEP)



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